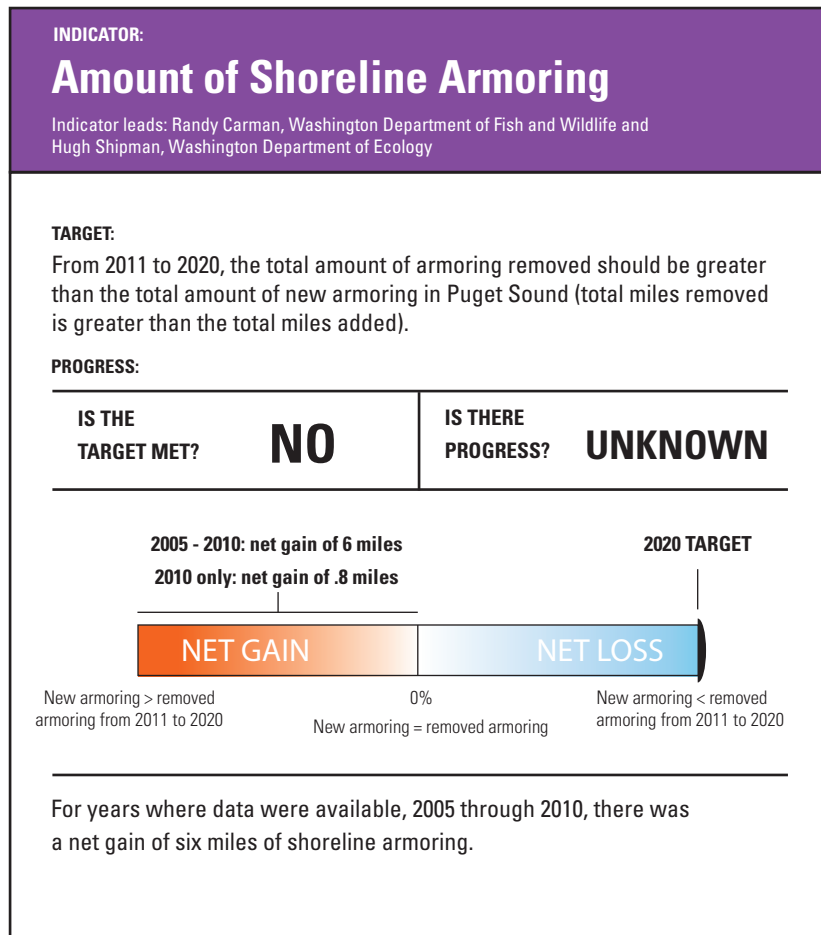


Shoreline Armoring

Puget Sound's 2,500 miles of shoreline are among the most valuable and fragile of our natural resources. A dynamic area where land and marine ecosystems meet, the shoreline is constantly changing with the action of wind, waves, tides, and erosion. These same shaping forces are also the reason why people often build bulkheads or other structures to harden the shoreline. Indeed, more than 25% of the shoreline has been armored to protect public and private property, ports and marinas, roads and railways, and other uses.

Shoreline armoring, the practice of constructing bulkheads (also known as seawalls) and rock revetments, disrupts the natural process of erosion, which supplies much of the sand and gravel that forms and maintains our beaches. Erosion also creates habitat for herring, surf smelt, salmon, and many other species in Puget Sound. Over time, shoreline armoring may cause once sandy beaches to become rocky and sediment starved, making them inhospitable to many of our native species.

Shoreline Armoring



Progress Towards 2020 Target

The analysis of current progress is pending due to ongoing compilation and analysis of 2011 data. However, we can use data from 2005 through 2010 to report on status and trends of shoreline armoring and make some predictions about progress toward reaching the target by 2020.

The amount of new shoreline armoring in Puget Sound was substantially greater than the amount removed for every year from 2005 through 2010 (Figure 1). Cumulatively, a net amount (new armoring minus removed armoring) of six miles of new armoring was constructed during this time frame, or on average, one mile of additional armoring per year. This pattern of net gain in armoring is the opposite of what is needed to meet the 2020 target.

However, the net amount of armoring per year declined by roughly 50% over these six years. This result is driven by the fact that more and more armoring has been removed annually since 2005, while additions have remained fairly constant. A notable exception occurred during 2006 and 2007, when new construction was highest, perhaps due to significant storms and shoreline damage that occurred early in the period. Despite this, the general trend of new versus removed armor has shown some movement towards the target. Even so, the fact remains that new armoring in Puget Sound was four to 400 times greater than removals from 2005 through 2010, overwhelming the small advance in removing armoring.

Although more armoring was removed each year between 2005 and 2010, it will take significant progress on both a) decreasing the amount of new armoring and b) increasing the amount of removed armoring to meet the target by 2020. If the recent pace of adding and removing armoring continues, an additional 10 miles of new armoring will be added to Puget Sound shorelines between 2010 and 2020, making it unlikely that the 2020 target will be met.

What Is This Indicator?

Although shoreline armoring is one of the indicators that measures the pressures on Puget Sound, rather than a measure of the state of the ecosystem such as the biomass of Pacific herring, it is an important indicator of ecological conditions in Puget Sound.

Shoreline armoring is the most common type of shoreline modification on Puget Sound. Armoring directly alters geologic processes that build and maintain beaches and spits. Bulkheads also impact erosion patterns on nearby beaches, alter beach substrate and hydrology, and reduce the availability of large wood.

These physical changes to beaches can diminish the availability and condition of key shoreline habitats. Armoring can also directly impact organisms and ecological processes by burying or displacing upper beach habitat and altering the natural transition between terrestrial and aquatic ecosystems. Impacts of armoring differ from one coastal setting to another, but have been demonstrated both on Puget Sound and elsewhere to impact habitat for fish, birds, and invertebrates.

Because of these adverse impacts on coastal processes and shoreline habitat, the goal is to decrease the amount of new armoring that occurs on Puget Sound, while also seeking opportunities to reduce armoring where feasible.

As new armoring is being constructed, concurrent efforts are deployed to remove armoring primarily for habitat

restoration. Thus, it is the difference between new and removed armoring that is of interest to address the target specifically, reported here as the net amount of shoreline armoring. To reach the target, there has to be a net loss of armoring cumulatively over 2011 to 2020.

Alterations to the shoreline are regulated primarily by two state laws, the Shoreline Management Act and the Hydraulic Code. Under the Hydraulic

**Puget Sound Shoreline Armoring Summary
2005–2010**

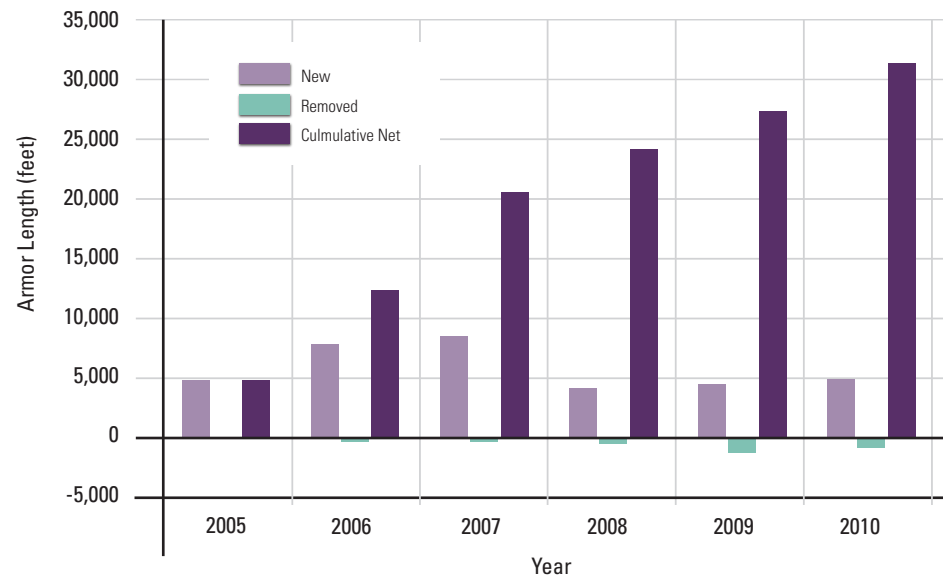


Figure 1. Amount of new armoring and removed armoring reported annually from 2005 to 2010 in Puget Sound, and the net amount of armoring accumulated since 2005. Data were compiled from the Hydraulic Project Approvals permits issued by the Washington Department of Fish and Wildlife.

Source: Washington Department of Fish and Wildlife, Habitat Program.

Shoreline Armoring

Code, project proponents seeking a permit for in-water and shoreline construction activities declare the amount of armoring they plan on adding, replacing, or removing in their application. Thus, data reported here were compiled from HPAs (Hydraulic Project Approval) issued from January 2005 through December 2010 by the Washington Department of Fish and Wildlife (WDFW). Projects were identified as: 1) new (previously unarmored shoreline), 2) replacement (complete replacement of existing armoring), and 3) removals (removal of existing armoring without replacement).

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) has been instrumental in compiling and reporting on changes to shorelines in Puget Sound over the past several decades. We relied on their data to report the length of shoreline and the overall amount of shoreline armoring in Puget Sound and by county.

Other Targets

Part of the 2020 target for shoreline armoring includes a focus on preventing new armoring and reducing existing armoring on feeder bluffs that supply sediments to Puget Sound shorelines. Activities are currently in progress to complete mapping of feeder bluffs in Puget Sound, including the condition of the



New Shoreline Armoring Distribution by County (2005-2010)

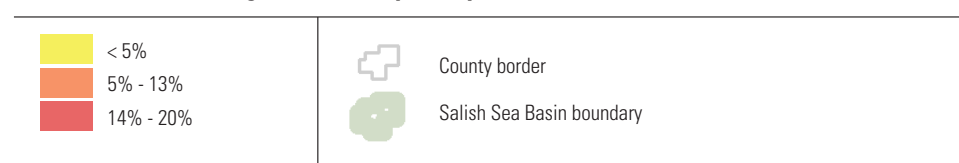


Figure 2. Amount of new armoring, county by county, as a percent of all new armoring in Puget Sound, cumulatively between 2005 and 2010. The numbers in the boxes are the percent of all new armoring and the amount of new armoring in feet for each county. Includes both hard and soft armoring
Source: Washington Department of Fish and Wildlife, Habitat Program.

bluffs. Until the feeder bluff mapping project is completed, it will not be possible to report on the amount of new armoring added or removed on feeder bluffs.

Similar language in the 2020 target refers to the use of soft shore techniques for new and replacement armoring where feasible. Reporting on this metric is currently constrained by the lack of adequate agreement on what constitutes a true soft shore project. Progress is being made to address this issue as part of a design guidance document currently being developed by WDFW and a consultant.

A total of 980 HPAs were issued for shoreline armoring projects in Puget Sound from January 2005 through December 2010. In all years, the amount of new armoring exceeded the amount removed (Figure 1). Just in 2010, the last year for which data were available, there were approximately 4,869 feet (0.9 miles) of new armoring, six times more than the amount of armoring removed (Figure 1). Furthermore, the amount of armoring replaced greatly exceeded either new or removed armoring.

Cumulatively, a net total of six miles of armoring was added in Puget Sound from 2005-2010, or, on average, one mile of additional armoring per year.

Interpretation of Data

Status and trends of Puget Sound wide armoring

Based on a compilation of a variety of data sources by the PSNERP, 27% of the shoreline of Puget Sound is armored (666 miles). Armoring is particularly extensive in highly developed residential, urban, or industrial centers. While most alterations to nearshore areas are heavily regulated, new and replacement shoreline armoring is still relatively commonplace for single-family residences, which accounted for more than three-quarters of the HPA permit applicants wishing to construct new armoring between 2005 and 2010 (Figure 3).

New shoreline armoring by applicant type

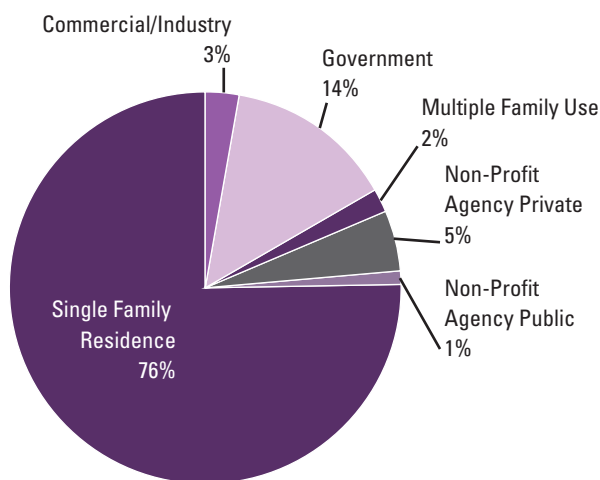


Figure 3. Percent of new armoring, by applicant type for years 2005-2010.

Source: Washington Department of Fish and Wildlife, Habitat Program.

Armoring removal by applicant group

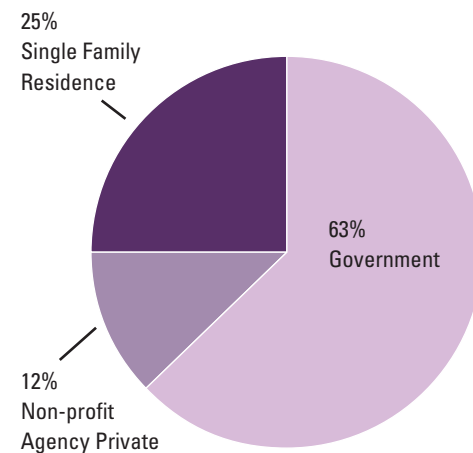


Figure 4. Percent of removed armoring, by applicant group for years 2005-2010.

Source: Washington Department of Fish and Wildlife, Habitat Program.

Shoreline Armoring

Overall, all project applications resulted in 6.5 miles of new shoreline armor, 0.61 miles of armor removal, and 14.45 miles of replacement armor.

There were no statistically significant linear trends in the amount of new or replacement armoring constructed through the six-year period. However, the amount of removed armoring significantly and steadily increased over the study period, albeit at a very small fraction of new armoring.

Increases in removals coupled with a reduced amount of new armoring for the second half of this period meant that the net amount of armoring declined between 2005 and 2010. During the first three years, the total net increase in armoring was 20,397 feet, compared to a total of 10,736 feet during the last three years. This is a 47% decrease in net new armoring constructed between the first and second half of the six-year period.

Armoring by counties

The total amount of shoreline armoring varies considerably across the 12 counties that border Puget Sound. Three counties account for nearly 50% of all the armoring in Puget Sound: King (13%), Pierce (18%), and Kitsap (16%) counties. These counties all have a high percentage of their shorelines armored: King 73%, Pierce 51%, and Kitsap 43%.

However, the HPA data revealed that most of the new armoring constructed between 2005–2010 was concentrated in somewhat different areas (Figure 2). Mason, Kitsap, and Island counties had the highest percentage of the new armoring, comprising a total of 51%. Pierce, San Juan and Skagit counties also accounted for a substantial amount of the new armoring with

a combined total of 34%. Therefore, six of the 12 counties in Puget Sound accounted for 85% of the new armoring from 2005 through 2010.

The same dataset indicates that armoring was removed in seven counties from 2005–2010. More armoring was removed in Kitsap County, totaling 1,873 feet (0.4 miles), than in any other county. A combined total of 1,353 feet (0.3 miles) was removed among the other six counties that included King, Pierce, Mason, San Juan, Island, and Jefferson. The remaining five counties in Puget Sound did not conduct any armor removal projects during the same time period.

The type of applicant that conducts new or armor removal projects was also compiled from the HPA data for years 2005–2010. Not surprisingly, most new armoring in Puget Sound (76%) was constructed on single family residence properties (Figure 3). In contrast, armor removal projects were primarily conducted on government properties (63%), whereas only 25% of the removals were on single family residential properties (Figure 4).

Powel Family Breaks Ground with Public-Private Partnership

Restoring Marine Nearshore Habitat

After nearly four years of restoration planning and design work, the Powel family and the Bainbridge Island Land Trust (BILT) broke ground on the Powel Shoreline Restoration Project at Port Madison in August 2012. This unique public-private partnership will restore more than 1,500 feet of natural shorelines on private property.

A showcase for other private shoreline landowners, the Powel Shoreline Restoration Project also increases awareness of the importance of and options for restoring nearshore habitats in Puget Sound on private land. The Powel family has been voluntarily working with BLIT, a local non-profit conservation organization, on restoration options and have donated a perpetual conservation easement now held by BLIT.

"I've sailed around Puget Sound and have seen the beauty and benefits of undeveloped, naturally functioning shorelines," said landowner Jake Powel. "We are excited for the opportunity to remove bulkheads, restore habitat, and improve beach access."

The Powel family has lived on Bainbridge Island for nearly 60 years. About 1,800 lineal feet of their property's shoreline had been hardened with bulkheads made of concrete, creosote logs, and other materials. The project will remove most of the bulkheads and increase important habitats on the property, including increasing intertidal habitat area by

About 1,800 lineal feet of their property's shoreline had been hardened with bulkheads made of concrete, creosote logs, and other materials

Aerial photo of the Powel Family property before the restoration efforts began.



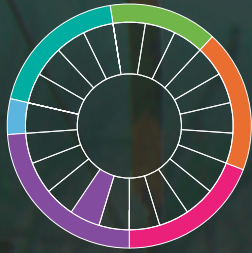
Powel Family Breaks Ground with Public-Private Partnership

163%, enhancing more than 32,000 square feet of marine riparian habitat, and almost tripling the amount of salt marsh habitat over time. The project focuses on restoring shallow intertidal habitat important to juvenile salmonids, particularly endangered Chinook, for migration, feeding, and refuge.

Funding for the project has been provided by the Powell family, BILT, and the State of Washington's Puget Sound Acquisition and Restoration (PSAR) fund, which is administered by the Salmon Recovery Funding Board and appropriated by the Legislature.



Representatives of the partners involved in the project: Tony Wright, Executive Director of the Puget Sound Partnership, Jim Brennan, Washington Sea Grant, Asha Rehnberg, BILT Executive Director, Ann Powell and Jake Powell (landowners)



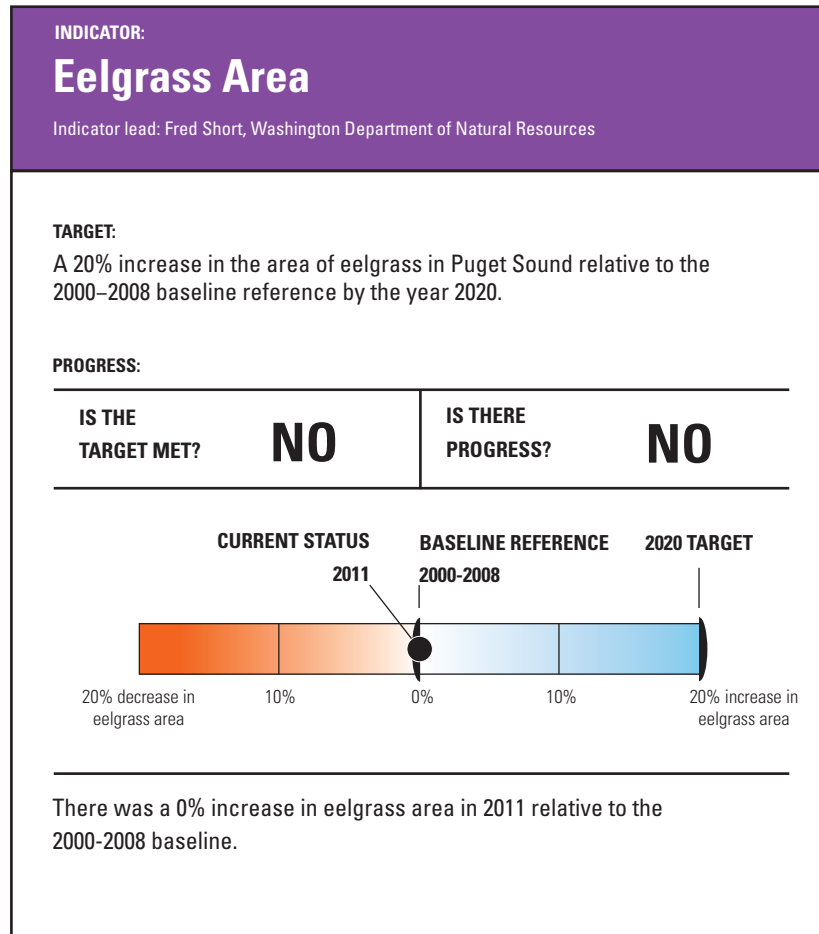
Eelgrass

Eelgrass grows in dense beds in the shallow waters of Puget Sound. This important marine plant serves as food source, nursery, and haven for birds, fish, crabs, shellfish, and other marine organisms. Eelgrass also filters sediments and nutrients, improving water clarity, and stabilizes the sea floor, which protects shorelines from erosion.

Eelgrass is valuable to the health of Puget Sound not only for the ecosystem functions it provides, but because it is sensitive to environmental stressors. Eelgrass health is an indicator of changing conditions in our watersheds and estuaries.

Although some larger Puget Sound eelgrass beds are stable, many of the smaller, fringing beds throughout the Sound are in decline. The reasons for this decline are not fully understood, but nitrogen pollution entering Puget Sound from human sources is likely having major impacts in many locations, while in other areas increases in sediment inputs and direct physical damage are stressing eelgrass beds.

Eelgrass



Progress Towards the Target

The Sound-wide area of eelgrass measured in 2011 has not changed relative to the 2000–2008 baseline reference, and thus there has been no progress towards the eelgrass 2020 target. The overall finding is that the majority of sampling sites across the Sound show no gains in eelgrass area. Furthermore, sites with decreasing trends in eelgrass area greatly outnumber those with increases, a concern for the health of eelgrass beds around the Sound.

Monitoring information indicates that the goal to achieve a 20% increase in eelgrass area by 2020 cannot be met with current management practices: the stresses on eelgrass in Puget Sound must be significantly reduced to see gains in eelgrass area and health.

What Is This Indicator?

Eelgrass (*zostera marina*) is an important submerged marine plant growing throughout Puget Sound. Changes in the abundance or distribution of this resource reflect changes in environmental conditions.

Eelgrass and other seagrass species are used as indicators of ecosystem health throughout the world because they respond sensitively to many natural and human-caused environmental factors that affect water quality and shoreline conditions. These factors are also likely to affect many other species that depend on eelgrass habitat.

For example, excess nutrients, sewage, and algae can reduce water clarity, while storms, runoff, and dredging can stir up sediment, preventing light from penetrating the water and reaching the eelgrass. Boat wakes, propellers, and docks can also disturb eelgrass beds.

Also, since eelgrass is protected by many regulations, its condition reflects, in part, the success of management actions. The Washington Department of Natural Resources assesses status and trends in eelgrass by evaluating eelgrass area and depth range at over 100 sites throughout Puget Sound annually, using a statistical sampling framework.

Two measures are used to demonstrate eelgrass status and trends in Puget Sound:

1. Sound-wide eelgrass area. The total area of eelgrass beds in Puget Sound.
2. Number of increasing, decreasing, or stable eelgrass beds. Count of eelgrass gains and losses on a site basis.

Interpretation of Data

Measure 1: Sound-wide eelgrass area

Puget Sound supports roughly 22,600 hectares of eelgrass beds (Figure 1). Eelgrass distribution patterns vary by sub-basin, with two main types of eelgrass beds: narrow fringing beds and broad beds on shallow flats. Approximately 25% of the total eelgrass area occurs in only two embayments: Padilla and Samish Bays.

There was no significant increasing or decreasing trend in eelgrass area in 2011 relative to the 2000-2008 baseline, calculated as the weighted mean of eelgrass area in that time period (Figure 1).

Measure 2: Count of eelgrass gains and losses on a site-by-site basis

A total of 211 sites are classified for eelgrass area trends. The majority of these sites are eelgrass beds where no change or trend in the size of the bed have been detected (170 sites; Figure 2).

Acres of Eelgrass in Puget Sound

in thousands, 2000-2008 baseline and 2009-2011 annual data

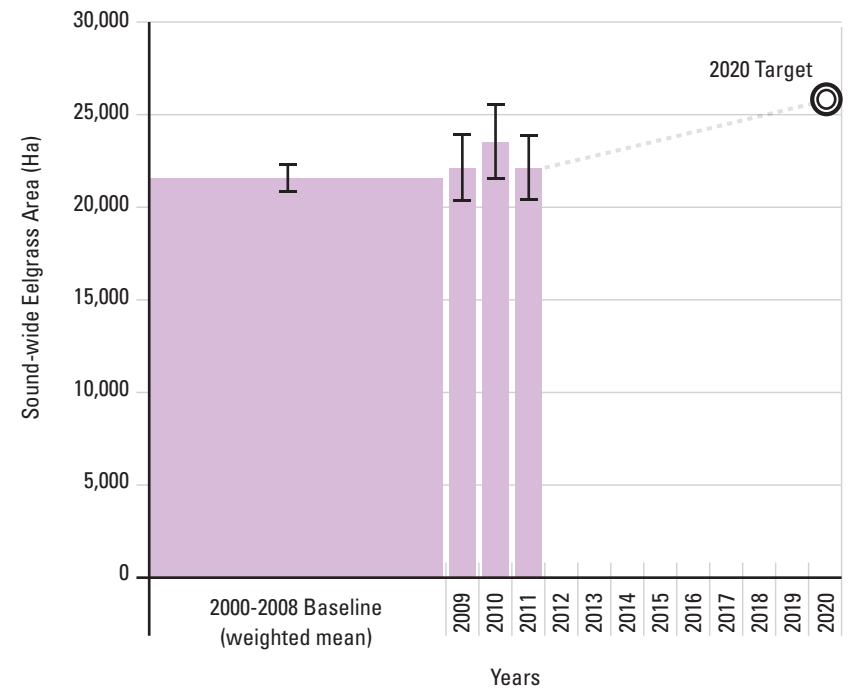


Figure 1. The annual estimates of Sound-wide eelgrass area for 2009-2011 compared to the baseline established by the Partnership's 2020 target for eelgrass recovery. Mean \pm standard error are shown.

Source: Washington Department of Natural Resources, Submerged Vegetation Monitoring Program

However, there are more than twice as many sites where the size of the eelgrass beds decreased than sites that increased. Of all sites analyzed, there were five cases of total eelgrass loss. In no region have improving eelgrass sites outnumbered declining eelgrass sites.

Eelgrass

Concerns about Hood Canal

Among the five eelgrass monitoring regions of Puget Sound, Hood Canal has the greatest number of sites where the amount of eelgrass decreased (Figure 3), including two sites where eelgrass beds completely disappeared. The Hood Canal region is a major concern particularly because 83% of changing sites are in decline. Another region of concern is the Saratoga-Whidbey Basin where 71% of changing sites are in decline.

The eelgrass in Hood Canal has been indicating signs of eutrophication: excess nitrogen loading from human sources contributes to the formation of seaweed blooms in the nearshore, which accumulate and grow in eelgrass beds, stressing the plants and contributing to the observed decline.

Although not related to human nitrogen loading and its impacts to eelgrass, stratification and low dissolved oxygen have been seen in this deep fjord-like basin. The localized eutrophic conditions in Hood Canal are evident throughout Puget Sound and pose a major threat to eelgrass and its health throughout the Sound.

Status of eelgrass sites in Puget Sound

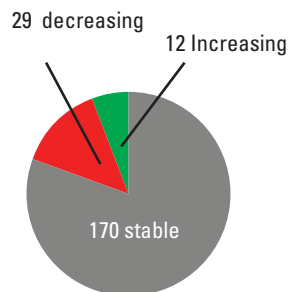
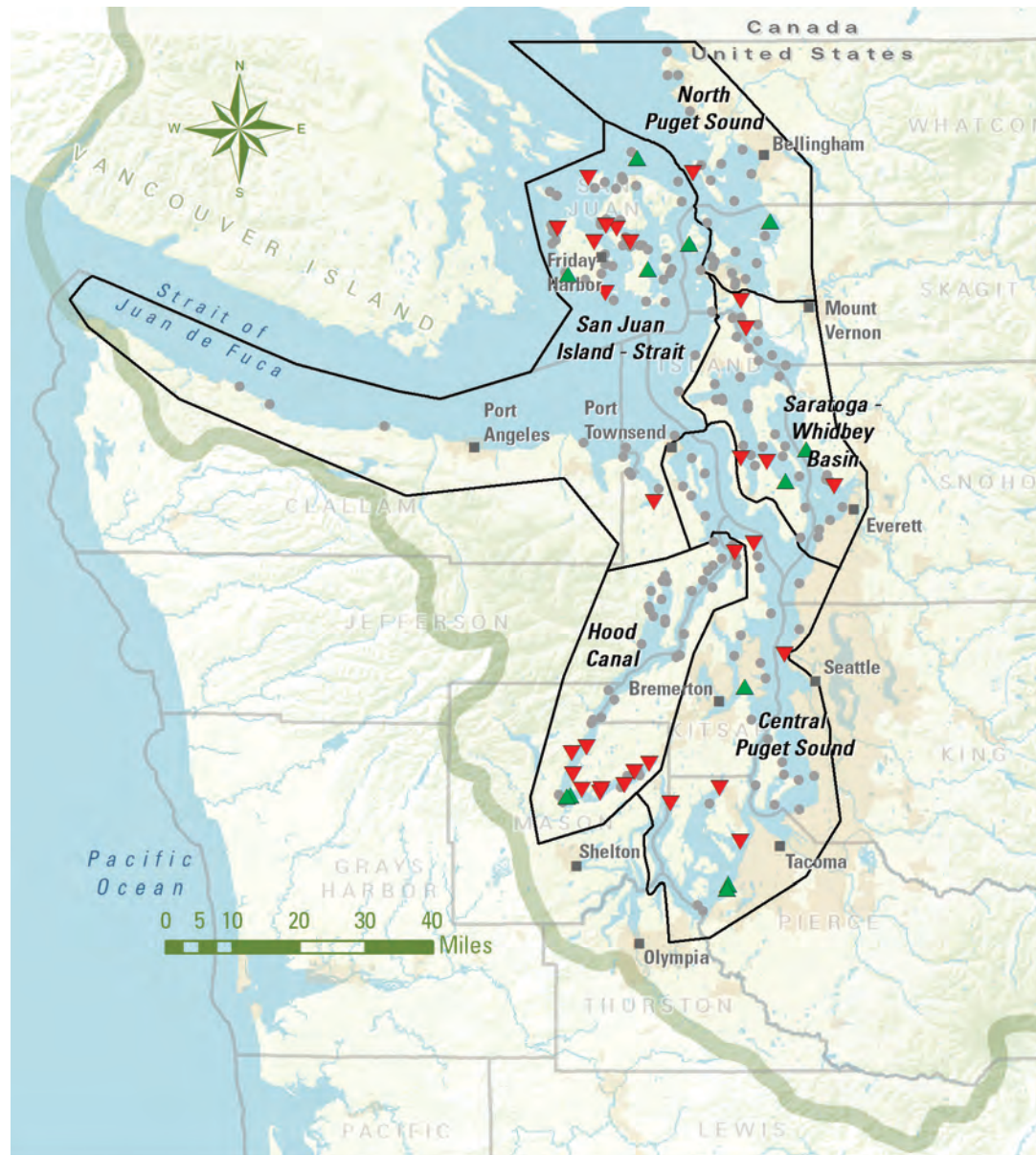


Figure 2. Number of sites in Puget Sound where the size of eelgrass beds increased, decreased, or remained stable since 2000.

Source: Washington Department of Natural Resources, Submerged Vegetation Monitoring Program

Figure 3. Distribution of eelgrass monitoring sites and their status.

Source: Washington Department of Natural Resources, Submerged Vegetation Monitoring Program



Eelgrass Monitoring Sites

- | | |
|-----------------------|---------------------------------|
| ▲ Increasing eelgrass | □ Eelgrass monitoring regions |
| ● Stable eelgrass | ■ Cities and urban growth areas |
| ▼ Decreasing eelgrass | ⬡ County border |
| | ⬢ Salish Sea Basin boundary |

Beach Watchers Keep an Eye on the Eelgrass

Washington State University Extension Island County Beach Watchers – Eelgrass Monitoring Project

Lush, subtidal beds of eelgrass provide habitat where snails and fish lay eggs, larvae thrive, crabs and forage fish reside, and young salmon seek shelter. Eelgrass dampens the impact of waves and resists the pressures of erosion. Knowledge about eelgrass in Island County is fueled by the Washington State University (WSU) Extension Island County Beach Watchers' Eelgrass Monitoring Project, which was born from a combination of university vision, knowledgeable and resourceful volunteers, a compelling question, and collaboration.

In the late 1980s, WSU Extension launched Beach Watchers to provide education, outreach, research, and stewardship for the marine environment in Puget Sound and the Salish Sea. Since its inception, the program in Island County has trained more than 400 volunteers, and each year it records more than 15,000 volunteer hours and monitors 30

*...more than 50 volunteers
have contributed more than
1000 hours to collecting
eelgrass data.*

Three WSU Island County Beach Watchers monitor eelgrass density and plant size in Holmes Harbor. Phot Credit: WSU Island County Beach Watchers

beaches. In 2002, Beach Watchers turned attention to eelgrass in a membership survey. Information and educational materials about eelgrass continued. The combination of increased eelgrass awareness, knowledge of the marine environment, and skillful observation fostered an important observation in 2007 when a Beach Watcher noted some eelgrass beds at Holmes Harbor had disappeared. The idea for the Eelgrass Monitoring Project soon followed. With funding from the Island County Marine Resource Committee, advice and assistance from the University of Washington Friday Harbor Labs and Washington State Department of Natural Resources (DNR), and a pilot study in

2008, the Eelgrass Monitoring Project was up and running at full-scale in 2009.

The Eelgrass Monitoring Project is conducted annually and includes three components: 1) a boat survey using underwater videography to document presence and absence of eelgrass along DNR-specified transects perpendicular to the shoreline at ten sites, 2) aerial photography during summer low tides to provide a broader look at eelgrass extent over a larger area, and 3) a boots-in-the-muck survey to count eelgrass leaves, measure plant density and water temperature, and gather vegetation samples in Holmes



Beach Watchers keeping an eye on the eelgrass

Harbor. Since program inception, more than 50 volunteers have contributed more than 1000 hours to collecting eelgrass data.

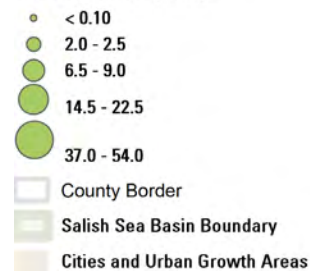
Surveys in 2009 and 2010 confirmed extensive eelgrass beds in Cornet Bay and Holmes Harbor. Damage to eelgrass beds was documented in Cornet Bay with the patterns suggesting possible damage from boating activities. Penn Cove surveys showed relatively few eelgrass beds with an unusual number of green sea urchins. Three years of study in Holmes Harbor point to eelgrass return and relatively stable beds since 2007 and suggest an unusual 2006-2007 winter storm from the north that coincided with an extreme low tide may have influenced the 2007 losses. Data from the eelgrass monitoring project are provided to DNR and are available on the Island County Marine Resource Committee's Sound IQ data system (www.iqmap.org/icSound-IQ/). These data on eelgrass, combined with other data on birds and mammals, intertidal habitats, fish distribution, and more are contributing to the overall understanding of the nearshore ecosystem around Whidbey Island.

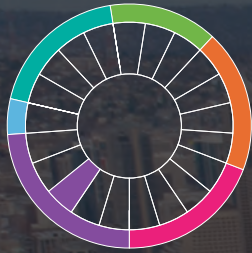


WSU Extension Island County Beach Watchers

2010 - 2011 Eelgrass Surveys

Estimated Bed Area (Acres)



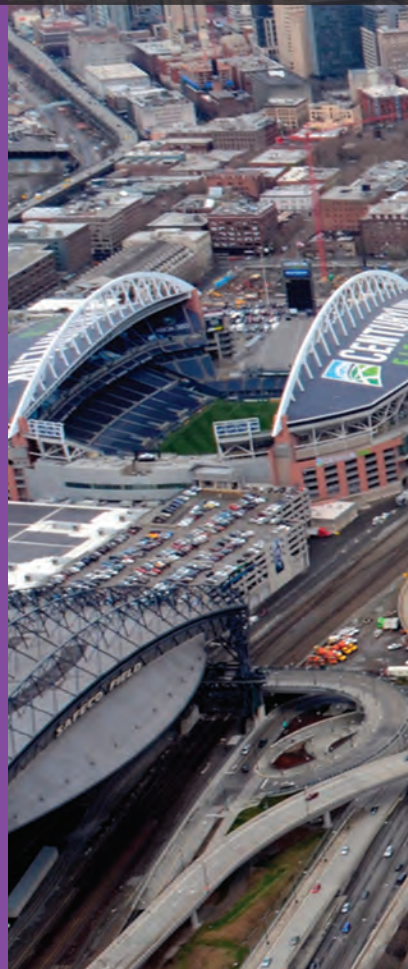


Land Development and Cover

In the Puget Sound region, we have lost at least two-thirds of our remaining old growth forests, more than 90% of our native prairies, and 80% of our marshes in the past 150 years.

The land surrounding Puget Sound is home to four million people who live, work, and play in our region. The need for homes, businesses, roads, and agriculture must be balanced with ecosystem protection. Forest and riparian areas provide important habitat for many species and reduce the rate of polluted runoff flowing into Puget Sound.

Land development and cover indicators measure how well we are directing our region's ongoing growth to protect our best remaining natural areas and working forests. In the future, with an additional Land Development Pressure indicator focused on the form and location of development, we expect to be able to determine how well we are concentrating population growth in those areas identified as most suitable for development.



Land Development and Cover

INDICATOR:

Land Cover Change: Forest to Developed

Indicator lead: Kenneth B. Pierce Jr., Washington Department of Fish and Wildlife

TARGET:

The average annual loss of forested land cover to developed land cover in non-federal lands does not exceed 1,000 acres per year, as measured with Landsat-based change detection.

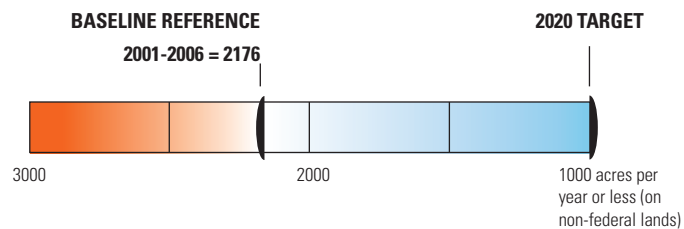
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

UNKNOWN



Baseline conversion rates: 2001-2006 conversion of forested cover to developed cover was 2,176 acres per year. Information on the rate of conversion from 2006 to 2011 is expected to be available in 2013.

Progress Towards 2020 Target

The 2020 target has not yet been reached, and progress towards the target is unknown due to lack of data.

Non-federal Puget Sound basin forest was converted to developed cover at a rate of 2,176 acres per year for the period 2001-2006. Data needed to calculate an updated conversion rate for the period 2006-2011 were not yet available, but are expected in 2013.

Achievement of the 2020 target rate of 1,000 acres converted per year would represent a roughly 50% reduction from the 2001-2006 annual conversion rate, or an 80% reduction from the 1991-2001 conversion rate of 5,048 acres per year. 1991-2001 was a period of unprecedented regional growth that included significant expansion of the developed landscape. Limiting the conversion rate to 1,000 acres per year is an ambitious target that reflects our need to minimize loss of regional forest cover while recognizing that some conversion of forest cover for the purposes of development and infrastructure development is necessary.

What Is this Indicator?

Forest conversion measures the loss of forested land cover to developed land cover. The indicator provides a check on our regional success in maintaining forest cover throughout the Puget Sound Basin.

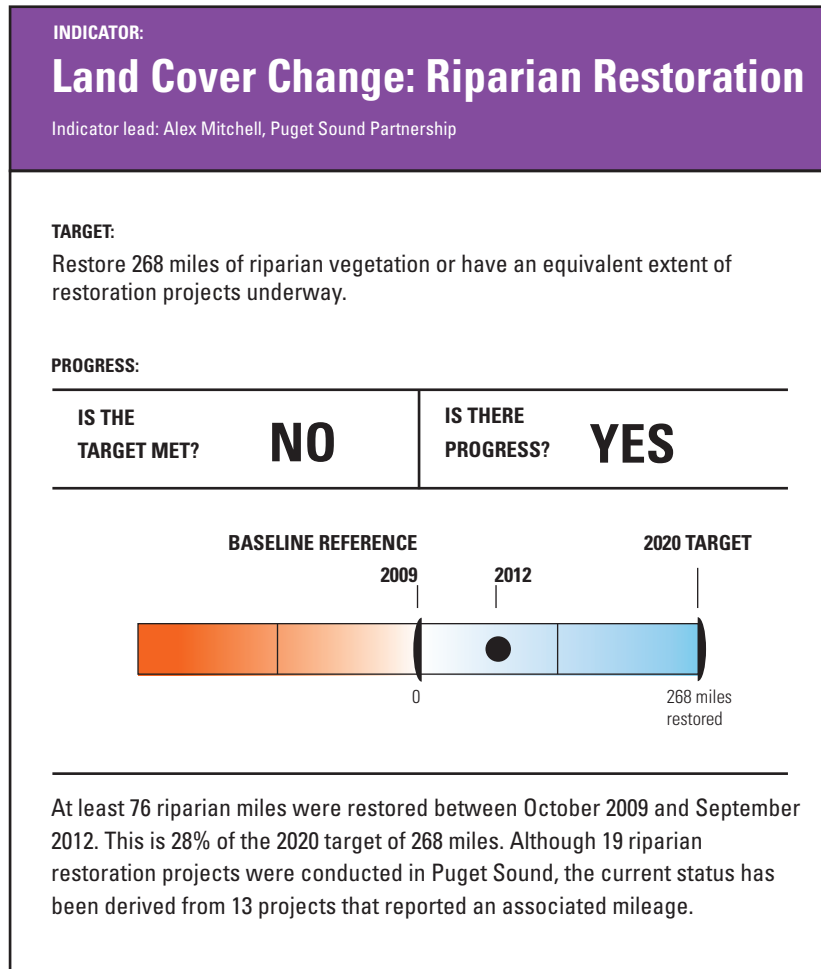
Forested landscapes, as measured by forest cover, provide the following: 1) habitat functions that support terrestrial species, 2) watershed functions that support freshwater systems, and 3) provisioning and cultural services for humans.

Change in forested lands is monitored using NOAA analysis of satellite imagery to track change from forested land cover, including coniferous, deciduous, and mixed forest classes, to developed land cover using four classes of development intensity, on a five-year basis. Forest cover conversion in the Puget Sound basin has been consistently measured every four to five years since 1992 with the next results expected in late 2012 for change during the period 2006-2011.

Interpretation of Data

The current trends and targets were set using land-cover change information for lands not in federal ownership as determined by the Landsat satellite imaging system. Due to image element limitations, this approach does not capture relatively small land use change, such as clearing for single homes or lot expansion, and therefore only larger events (more than two acres) are reliably captured in these values.

Land Development and Cover



Progress Towards 2020 Target

The 2020 target has not yet been reached. Habitat data collected by the Puget Sound Partnership on behalf the Environmental Protection Agency indicate that 19 riparian restoration projects were conducted in the Puget Sound basin from October 2009 through September 2012. However, miles of restored riparian corridors were reported only for 13 projects. In total, at least 76 miles were restored during that time period, or 28% progress towards the 2020 target of 268 miles. It should be noted that riparian corridor restoration prior to October 2009, the baseline reference year, was not counted towards the target.

What Is This Indicator?

The riparian vegetation restoration indicator measures the amount of new vegetated cover delivered by restoration projects along riparian corridors. These corridors are a critical component of the Puget Sound ecosystem and the indicator evaluates the effect of direct efforts to improve them. Intact, vegetated riparian corridors are critical for the following reasons: 1) keeping fresh and marine waters clean and cool, 2) moderating variability in water volume and timing of flow (i.e. flood storage), and 3) as key habitat for myriad terrestrial, freshwater and interface (e.g. salmon) species.

The amount of riparian corridor restored to vegetated cover will be measured through collection of acreage or linear riparian shoreline restoration reported for Puget Sound restoration projects. Riparian restoration efforts are being measured instead of riparian condition due to the difficulty in assessing riparian condition Sound-wide and the length of time necessary to call

a specific location successfully restored. Although tracking total riparian condition is a much more difficult task than tracking regional forest cover, the initiation and completion of restoration activities are trackable measures. Successful restoration may take many years and measuring its success will require ongoing monitoring. Recent restoration efforts in the Puget Sound basin have included 19 projects completed from October 2009 to September 2012 to restore riparian vegetation. These projects involved planting and other actions beyond treatment to remove invasive species. A project length was reported for 13 of the projects.

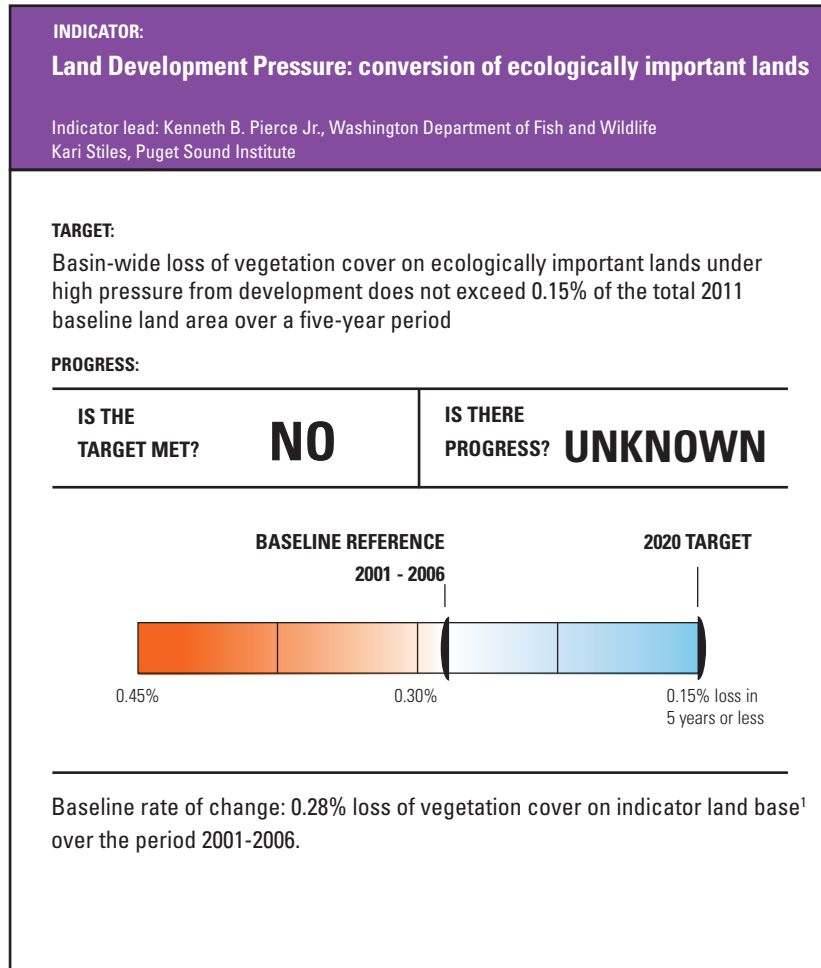
Interpretation of Data

The sum of the lengths reported for the 13 projects between October 2009 and September 2012 is about 76 miles, which is 28% of the 2020 target. If the median project length were applied to the six projects with no length estimate provided, we would estimate that the total mileage restored in this three-year period at 86 miles, which is 32% of the 2020 target.

Data Source

Puget Sound Partnership staff analysis of data for federal fiscal years 2010, 2011, and 2012 primarily from the Recreation and Conservation Office's PRISM database and reports of Natural Resource Conservation Service (NRCS) habitat programs.

Land Development and Cover



¹ Indicator land base = ecologically important lands under high pressure from development

Progress Towards 2020 Target

The 2020 target has not been met yet, and the analysis of progress towards the target is pending due to the lack of data, which will be available in 2013. However, achieving the 2020 target will require reducing the conversion of ecologically important lands to development to just over one-half the rate of conversion observed in 2001–2006.

The five-year baseline rate of land cover change on the indicator land base across all 12 counties in Puget Sound for the period 2001–2006 was 0.28%. Similar analyses will be completed every five years to track change over the periods 2006–2011, 2011–2016, and 2016–2021.

What Is This Indicator?

The indicator tracks the conversion from vegetated cover to developed cover on undeveloped lands identified as ecologically important and that are under high pressure from development for residential, commercial, and industrial uses. This indicator was developed in 2011 as part of a larger effort to define the ecological importance and development pressure for all parcels within the Puget Sound basin. Indicator lands—one of four land base types that were defined—include those parcels determined to be ecologically important and under high pressure from development. The other three land base types include 1) areas determined to be ecologically important under low pressure from development, 2) areas of lower ecological importance and high development pressure, and 3) areas of lower ecological importance and low development pressure.(Figure 1).

A parcel's ecological importance was determined using Ecology, WDFW, and PSNERP data identifying areas of high significance and high integrity with respect to hydrological dynamics, habitat quality, or biodiversity. Areas under high pressure from development included parcels with less than 35% impervious surfaces in private ownership with limited or no regulatory protection.

Because of the coarse scale approach to defining ecologically important lands in the indicator land base, this indicator is appropriately used to identify broad regional trends. This indicator's results are not intended for use in local decision-making, permitting, or planning.

This indicator provides a regional measure of the effectiveness of local jurisdictions' efforts to direct growth away from undeveloped ecologically functional areas. Specifically, the indicator provides a measure of the success of local governments in identifying and protecting ecologically significant and intact lands within and outside of Urban Growth Areas, a priority strategy in the Puget Sound Action Agenda.

It is also an indicator, though perhaps a weaker one, of how effectively local jurisdictions are using or incorporating landscape characterization methods, or other ecologically based information, into their land use decision-making.

Interpretation of Data

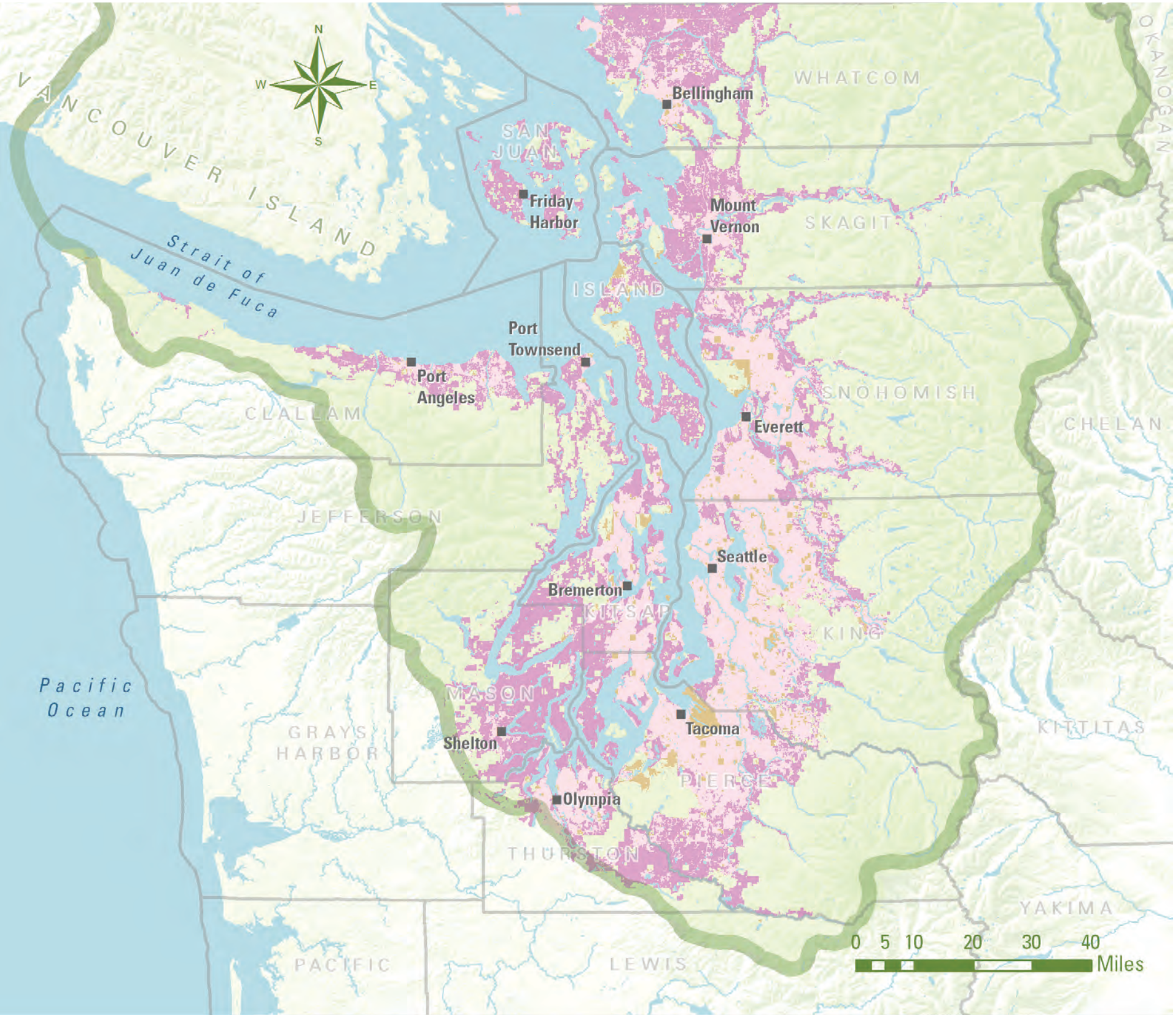
The 2011 indicator land base represents 13% of the total Puget Sound land area (Table 1). As shown in Figure 1, most of the indicator land base lies around the urban fringe, outside of urban growth areas (UGAs) in the Puget Sound lowlands. The parcels that make up the indicator land base often fall along transportation corridors that are also important habitat and hydrological corridors, within the region's most productive farmlands (e.g. around Mount Vernon and north of Bellingham), and in lowland forested areas to the south and west of the Puget Sound. Although the parcels typically fall outside of areas identified as the highest priority and most suitable areas for growth and development (i.e. UGAs), in most cases there are no protective measures in place to direct growth away from these ecologically important areas.

Land Cover Change from Vegetated to Developed, 2001–2006

Land Base Type	Land area (proportion of total Puget Sound land area)	Area converted 2001-2006 (acres)	Proportion of area converted 2001-2006	Proportion of total Puget Sound 2001-2006 conversion
Indicator Land Base high ecological importance, high development pressure	1,084,785 (13%)	2,996	0.28%	15%
high ecological importance, low development pressure	5,737,559 (68%)	1,140	0.02%	6%
low ecological importance, high development pressure	1,101,134 (13.0%)	10,136	0.92%	50%
low ecological importance, low development pressure	558,315 (7%)	6,077	1.09%	29%
TOTAL	8,481,793	20,349	0.24%	

Table 1. Land cover change from a vegetated class to a developed class over the period 2001-2006 in twelve Puget Sound counties.

Source: Washington Department of Fish and Wildlife, Habitat program. Analysis based on many federal, state, and local data sources



The majority of the land area in Puget Sound (68%) is classified as high ecological importance and low pressure from development. This land base type is primarily made up of publicly owned forest and protected lands, privately owned large scale forest lands, and privately owned protected lands. The remaining 20% of the land area is classified as low ecological importance with high and low development pressure and includes significantly ecologically degraded areas.

A 2011 12-county analysis of land cover change reveals a loss of vegetative cover on 0.28 % of the indicator land base (2,996 of 1,084,785 acres) over the period 2001–2006 (Table 1). This is equivalent to 15% of total vegetation loss in Puget Sound for the period 2001-2006. In contrast, the land area classified as high ecological importance but under low pressure from development only experienced 6% of basin-wide vegetation loss. These preliminary results suggest that protective measures are influencing where development is occurring but it is not yet possible to say how much of the lower conversion rate on low pressure lands is due to protective measures

versus suitability for development. The remaining 79% of vegetation loss for the five-year period 2001-2006 occurred on lands classified as low ecological importance, with 50% and 29% of vegetation loss occurring on high and low development pressure lands, respectively.

This analysis suggests that regulatory and other protective measures are directing much of the region’s development away from ecologically important lands. However, with roughly 20% of vegetation loss still occurring on ecologically important lands, there is significant room to improve the degree to which we are directing and concentrating new growth in those areas that are not as critical for maintaining and recovering the health of Puget Sound species, habitats, waters, and people.

◀ Land base types

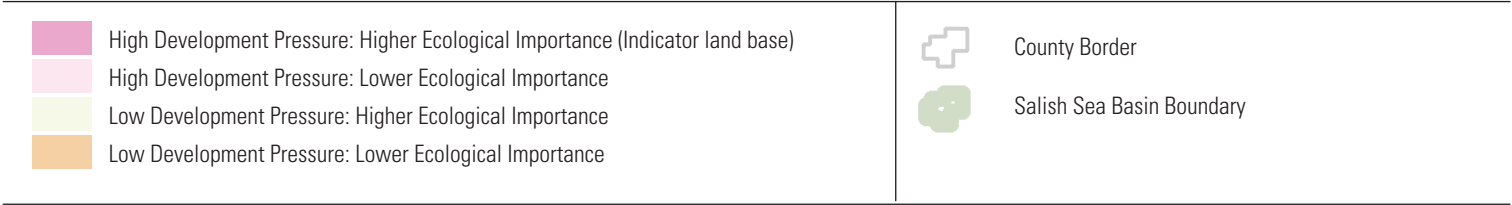


Figure 1. Distribution of land base types in Puget Sound.
Source: Washington Department of Fish and Wildlife, Habitat program. Analysis based on many federal, state, and local data sources

Land Development and Cover

INDICATOR:

Land Development Pressure: Proportion of Basin-Wide Population Growth Distribution within Urban Growth Areas (UGAs)

Indicator lead: Kenneth B. Pierce Jr., Washington Department of Fish and Wildlife
Kari Stiles, Puget Sound Institute

TARGET:

The proportion of basin-wide growth occurring within UGAs is at least 86.5% (equivalent to all counties exceeding their population growth goals by 3%), with all counties showing an increase over their 2000–2010 percentage.

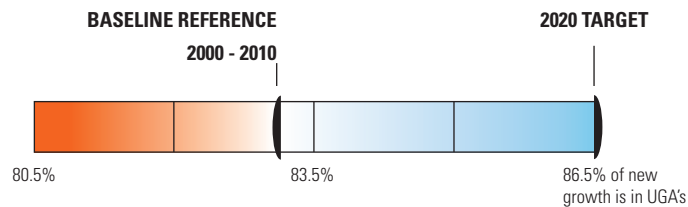
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

UNKNOWN



Based on basin-wide census data from 2000 to 2010, 83% of new growth occurred in UGAs. This value serves as the baseline for future analysis of progress.

Progress Towards 2020 Target

The 2020 target has not yet been met. Based on U.S. census data from 2000 to 2010, the Puget Sound basin-wide population growth occurring within UGAs was 83% (Table 1). For counties, this indicator ranged from 28-101%. The analysis of progress towards the 2020 target is pending until new data are made available. For future analyses of progress, the value derived from the 2000 to 2010 census data will be used as a baseline reference for basin-wide (83%) and county-scale (ranging from 28-101%) population growth distribution.

The 2020 recovery target of 86.5% of population growth occurring within UGAs is equivalent to a 3% increase in the proportion of new population growth occurring within all Puget Sound UGAs. This target represents an effort to direct more growth to those areas deemed best suited for development, while also respecting that Puget Sound includes very urban as well as very rural counties with very different growth management needs and objectives. Data on the distribution of permits for new development (a proxy for population growth) within five of the 12 Puget Sound counties suggest that the target is achievable.

What Is this Indicator?

This indicator tracks the proportion of population growth occurring within UGAs. Population growth is used as a surrogate for development activity in the region. Ten-year U.S. Census data are used for this indicator and the analysis will be updated when census data are next available in 2020. In order to generate intermediate measures of population growth distribution and assess progress toward the target, the less precise U.S. Census American Community Survey will be used.

County comprehensive plans designate UGAs for high-density urbanization with the intent to guide as much growth as possible to these areas to support regional and local economies, meet residence needs for a growing population, and be concurrent with infrastructure availability. This indicator therefore provides a measure of the effectiveness of land use policies and programs. It also measures the effectiveness of development practices in directing new development activities within existing urbanized areas and reducing land development pressures on rural and resource lands outside of urbanized areas.

Interpretation of Data

Washington population data, based on 2010 U.S. Census data, was used for the baseline analysis of population growth distribution for UGAs and rural areas between 2000 and 2010 (Table 1). Basin-wide, 83% of new population growth from 2000 to 2010 occurred within UGAs. For individual counties, the proportion of growth occurring within UGAs ranged from a low of 28% for Mason and Jefferson counties to highs of 92% and 101% for Snohomish and King counties, respectively.

Data are not currently available to complete a trend analysis of population distribution patterns over the past ten years. However, the Washington Department of Commerce has been collecting data on the distribution of permits for new development and a preliminary analysis suggests that growth is increasingly occurring within UGAs. For five central Puget Sound counties, the proportion of permits for new development within UGAs increased at an average rate of 0.85% per year from 2003 to 2010. Carried out over 10 years, these permit data suggest an almost 10% increase in the proportion of growth going into UGAs in central Puget Sound. While permit activity does not correlate exactly to population increase, these reports provide an indication of progress (in a five county area) toward the 2020 recovery goal of an increasing proportion of population growth with UGAs.

Number of people within and outside UGAs from 2000-2010, by county and basin-wide

County	2010 population	2000-2010 Total new population	% New population within UGA 2010	% New Growth (2000-2010) occurring within UGA
Clallam	64,262	7,546	50.0%	47%
Island	78,506	7,878	30.9%	40%
Jefferson	28,605	3,532	41.4%	28%
King	1,931,249	195,569	93.6%	101%*
Kitsap	251,133	20,418	62.1%	65%
Mason	60,699	13,931	27.1%	28%
Pierce	795,225	95,538	82.5%	85%
San Juan	15,769	1,986	21.6%	37%
Skagit	116,901	14,608	67.6%	83%
Snohomish	713,335	107,775	83.0%	92%
Thurston	252,264	76,584	67.6%	50%
Whatcom	201,140	35,034	67.4%	78%
Basin-wide	4,509,088	580,399	81.7%	83%

Table 1.

Sources: Washington Department of Fish and Wildlife, Habitat Program and the U.S. Census.

* This number reflects new growth occurring within UGAs and migration of some existing population into UGAs.

Conserving the Lifeblood of Puget Sound

We Cannot Restore the Sound Without an Accurate Stream Inventory

Jamie Glasgow, Director of Science and Research, Wild Fish Conservancy

The challenges facing Puget Sound reach beyond its deep inlets and sinuous shorelines, all the way to the crests of the Cascades and Olympics and into the rivers and streams that are the Sound's lifeblood. The streams that flow into Puget Sound form an integral part of its physical, biological, and chemical integrity. When those streams are inadequately protected, the consequences affect Puget Sound as surely as water flows downhill.

State and local government agencies in Washington are charged with protecting Puget Sound's streams from negative impacts caused by adjacent land-use activities. In many cases that charge hasn't been met for a surprisingly simple reason: agencies have been relying on inaccurate maps.

In Washington, the responsible agencies depend on a process called water typing to identify as well as categorize streams, lakes, and wetlands based on their importance, both ecologically and for human uses. Water typing answers the question: "Where are the streams, and where are the fish habitats within them?" This basic inventory is the most fundamental step in conserving the health of Puget Sound and its tributaries.

Unfortunately, current water typing records and maps often underestimate the actual miles of fish-bearing waters

by 50% or more. Wild Fish Conservancy has documented widespread error throughout Puget Sound in designating streams as fish-bearing or non fish-bearing. We have found that a significant number of streams in Puget Sound do not even appear on any maps. Hundreds of miles of productive Puget Sound watersheds are threatened because, when they are misidentified or unidentified on regulatory maps, they are often subjected to inappropriate land-use practices. Many streams are not receiving protection they warrant under already existing regulations.

Unless the watersheds draining into Puget Sound are accurately identified and protected, cumulative effects from the development of these watersheds will continue to contribute to the compromised health of Puget Sound. And until systematic inventories are performed, regula-

tory maps updated, and streams adequately protected, progress towards a healthy Puget Sound will continue to be significantly offset by the pervasive and in many cases unrecorded loss of freshwater habitat and water quality.

HOW WATER TYPING WORKS, AND DOESN'T

In 1975 the Washington Department of Natural Resources (WDNR) developed the process of water typing to regulate forest practices that impact Washington's surface waters, classifying streams into types depending on their physical, biological, and human-use characteristics. Stream reaches that can support fish are classified as Type F, and non fish-bearing streams are classified as Type N. Accurate water



Conserving the Lifeblood of Puget Sound

typing is essential to protecting fish and their habitats because the type and proximity of human activities allowable in areas adjacent to streams and other surface waters is dictated by water type. For example, streamside buffer zones required on Type F streams are larger than those required on Type N streams. In some cases, Type N streams receive no protection at all.

Since 1994, Wild Fish Conservancy has been physically surveying streams throughout Washington to correct their misclassification and qualify them for the protection warranted under existing laws. Funded by U.S. Fish and Wildlife Service in 1994, Wild Fish Conservancy assessed water type in a randomized subsample of watersheds between the Canadian Border and the Columbia River. Since then, using the state-sanctioned watertype survey protocol we have corrected the watertype classification of over 7000 stream reaches statewide.

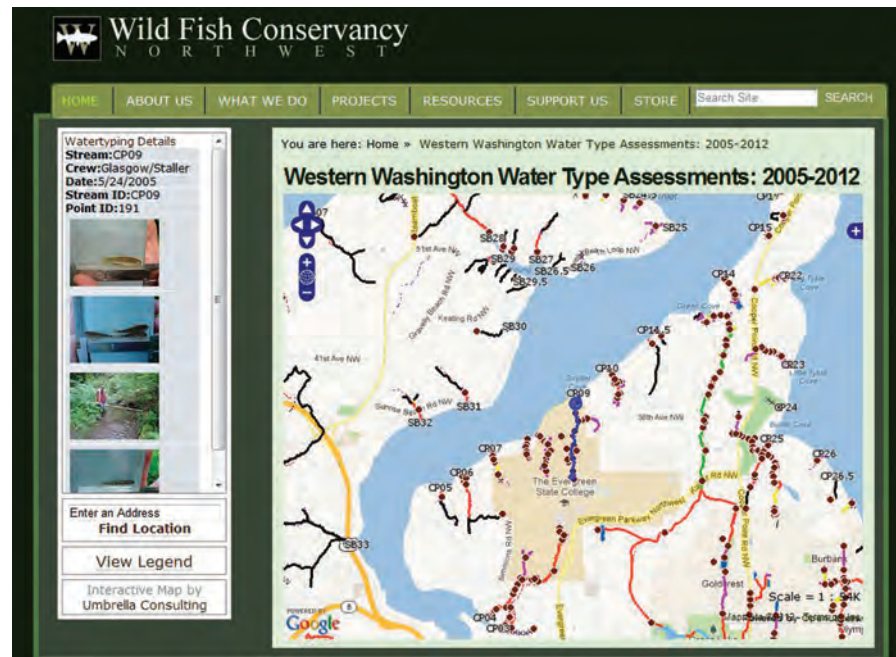
A CRISIS IN REGULATING DEVELOPMENT

Though originally designed for defining stream buffer requirements for forest practices, the WDNR water typing regulatory maps have been widely adopted by city and county government agencies for regulating development activities outside the forest-practice zones. Recent Wild Fish Conservancy watertyping surveys in rural and suburban landscapes in King, Snohomish, Jefferson, Thurston, Mason, San Juan, Kitsap, and Island counties documented significant errors in the regulatory maps. Many stream reaches identified on the regulatory maps as Type N were found to support fish, and many streams did not even appear on the maps.

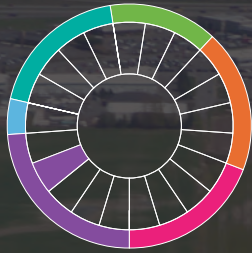
CASE IN POINT: Snyder Cove Creek

A small watershed located on Cooper Point in west Olympia, Snyder Cove Creek flows directly into Eld Inlet in South Puget Sound. Prior to a Wild Fish Conservancy survey, the regulatory water type maps identified 0.2 miles of stream channel where Wild Fish Conservancy documented 1.4 miles – a 600% increase in stream length. The regulatory

map had identified only 14% of the actual stream network. Unfortunately, the inaccurate stream channel mapping and the underestimated extent of fish habitat exhibited in Snyder Cove Creek regulatory map is not anomalous. Without watertype assessments to correct the inaccurate regulatory maps, watersheds like Snyder Cove Creek are not likely to be afforded adequate protection—protection they warrant under existing regulations.



Wild Fish Conservancy online mapping tool



Floodplains

Floodplains work like giant sponges. As rains increase with fall storms and snowpack melts in the mountains in spring and early summer, waters in the rivers around Puget Sound rise and flood low-lying land along the rivers and streams. In addition to absorbing this overflow, floodplains provide functions and services like refuge, food, and fresh water for a variety of species, good agricultural land through soil and habitat formation, and flat land that supports a variety of human uses.

Unfortunately, the functions and services in large areas of floodplains in Puget Sound have been lost through a combination of shoreline armoring and levees, as well as residential, commercial, industrial, and agricultural development. Improving riverside and floodplain habitat is a key part of virtually all recovery plans for endangered salmon. Restoration and better management of floodplains are essential for both recovering salmon and Puget Sound.

Floodplains

What is This indicator?

Currently there is no agreed-upon definition of a floodplain. A working group comprised of floodplain experts is developing definitions and data for this target, which will be available in 2012.

Although floodplains data are under development, based on other studies the National Oceanic and Atmospheric Administration (NOAA) estimates that almost three-quarters of wetlands have been lost in Puget Sound, the vast majority of which occurred in floodplains. Floodplain functions and services have been lost through a combination of shoreline armoring, levees, and residential, commercial, industrial, and agricultural development.

The Leadership Council set two 2020 targets for floodplains:

1. Restore, or have projects underway to restore, 15% of Puget Sound floodplain area.
2. Have no net loss of floodplain function in any watershed.



Estuary Restoration

River delta estuaries form where river floodplains meet the sea, creating a unique and important environment where freshwater mixes with salt water and sediments collect. A diverse array of specially adapted plants and animals thrive and take advantage of the fertility there, moving in and out with the tides. Estuaries provide important feeding and resting habitat for young salmon, migratory birds, and many other species that cannot find these unique benefits in any other place in our landscape. For example, young salmon that can rear longer in delta estuaries grow faster and are more likely to survive their ocean migration.

Estuary Restoration

INDICATOR:

Estuary Restoration

Indicator lead: Paul Cereghino (NOAA Restoration Center)

TARGET #1:

By 2020, all Chinook natal river deltas meet 10-year salmon recovery goals (or 10% of restoration need as proxy for river deltas lacking quantitative acreage goals in salmon recovery plans)

PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

N/A



Salmon recovery plans are in the process of being updated, and measurable restoration goals are being defined.

INDICATOR:

Estuary Restoration

Indicator lead: Paul Cereghino (NOAA Restoration Center)

TARGET #2:

7,380 quality acres are restored basin-wide, which is 20% of total estimated restoration need.

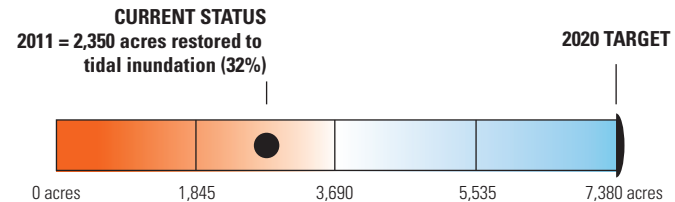
PROGRESS:

IS THE
TARGET MET?

NO

IS THERE
PROGRESS?

YES



As of 2011, approximately 2,350 acres of estuary lands have been restored to tidal inundation since 2006, about 32 percent of the amount needed to reach the 2020 target.

Progress Towards the 2020 Target

Neither of the two 2020 targets for estuaries have been met yet, but there has been progress on target 2 (number of quality acres restored). Although this may indicate progress towards salmon recovery goals, progress towards target 1 cannot be measured because recovery plans are in the process of being updated, and measurable restoration goals are being defined.

Approximately 2,350 acres of estuary lands have been restored to tidal inundation in the 16 major Puget Sound river mouth estuaries (Figure 1). Data summarized here are provisional because each watershed characterizes estuary restoration differently. The Partnership is working with other agencies and watershed groups to standardize how estuary restoration is measured and reported.

Significant restoration work has been implemented in the Nisqually, Skokomish, and Quilcene river delta systems, restoring a large proportion of area historically subject to tidal flooding. Substantial projects have also been completed in the Nooksack, Skagit, Snohomish, and Stillaguamish estuaries, but these remain modest when compared to the original historic extent of these larger river delta systems. Smaller projects have been completed in several deltas, including Duckabush, Dosewallips, and Dungeness.

The Duwamish and the Puyallup river deltas, two of the most industrialized in Puget Sound, have seen substantial activity associated with Natural Resource Damage Assessment efforts. But acreage gains there are modest in terms of restoring tidal inundation, and there are fewer options in those highly developed systems compared to some levee and dike setback opportunities in less developed systems.

Estuary Acres Restored to Tidal Inundation by Year

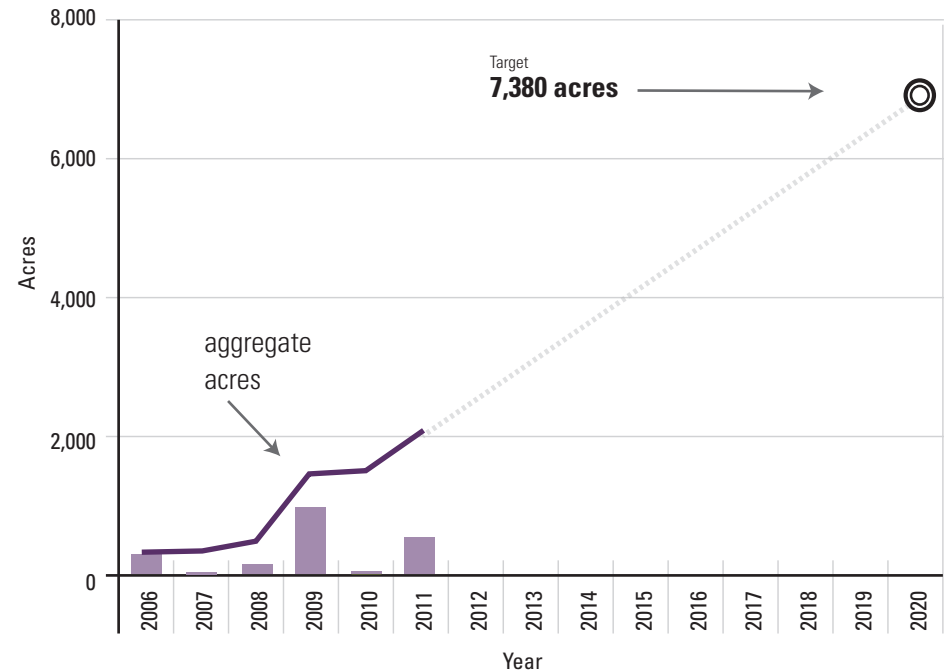


Figure 1. Approximate acres of estuarine lands where tidal flow has been restored for projects completed between 2006-2011 in the 16 major Puget Sound river mouth estuaries (data for 2009 includes the Nisqually estuary refuge restoration project of 762 acres). Columns show annual amounts, and the line shows the cumulative acres.

Source: National Estuary Program Online Reporting Tool (NEPORT), Environmental Protection Agency

Estuary Restoration

What is This Indicator?

The estuary restoration indicator tracks the amount of land returned to tidal inundation. Until more robust measures become available, we generally assume that restoring tidal flooding to historic estuarine lands will improve the natural habitat functions and productivity of those lands.

Many estuarine restoration projects have been undertaken in Puget Sound. However, they have been planned, funded, and implemented over a decade or more by many different organizations, including local governments, state and federal agencies, watershed groups, tribes, and private organizations and landowners. Unfortunately, project reporting is scattered and inconsistent, mapping and survey methods are not standardized, and the accuracy of completed ("as-built") project reporting is highly variable.

Consequently, the data reported here represent only a rough estimate of the actual area treated. Project reporting has been subject to considerable variability over the years, and our results were obtained from several different and inconsistent databases designed to collect project data (including PRISM, Habitat Work Schedule, and NEPORT). Efforts are underway to standardize how estuarine restoration efforts are reported and characterized. The intent is to eliminate inconsistencies and gaps in data and improve our ability to track actual net gains and losses of estuarine habitat.

Interpretation of Data

Historic trends

In Puget Sound there are 16 large river-mouth estuaries: nine larger deltas drain the Cascade Mountains, and seven smaller deltas drain the Olympics. These estuaries and wetlands were a cornerstone of the Puget Sound ecosystem and served as a critical nursery for historically large populations of now-threatened Pacific salmon.

Over the last 150 years, the region has suffered dramatic losses of intertidal wetlands. Of the approximately 62,000 acres of mapped historical swamp and marsh, only an estimated 14,640 acres remain. The swamps of the Skagit and Snohomish once contained over 37,000 acres alone (compared to around 1,620 acres for all the Olympic deltas combined). In the most highly developed river mouth estuaries, such as the Duwamish and Puyallup Rivers, estuarine habitat has been reduced to only a tiny fragment of its original extent, and may never be recovered.

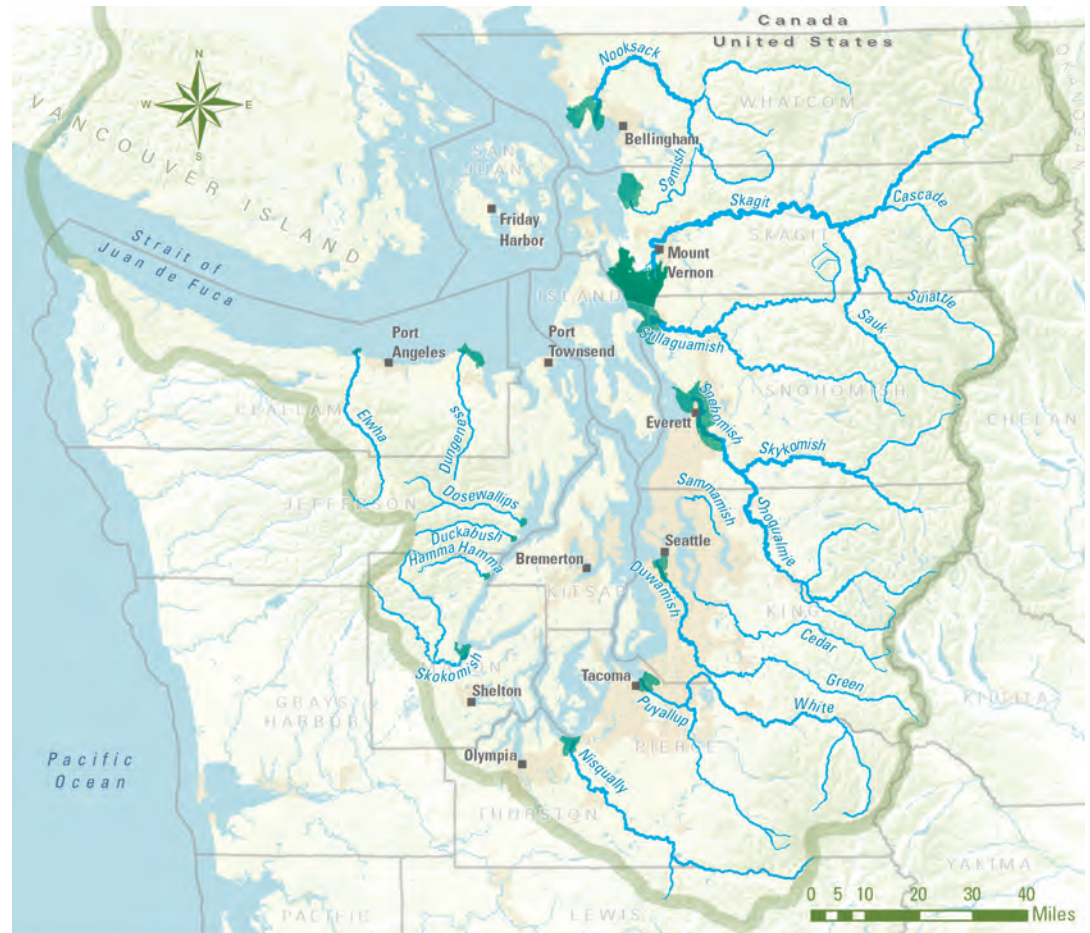
Much of the loss can be attributed to the development of natural waterways for economic and commercial purposes. Across the region, estuaries and tidal wetlands have been diked, drained, or filled. They have been converted to farms and agriculture, or developed into modern ports and industrial sites. Loss of intertidal wetlands has contributed to the decline of many species, including especially Chinook and chum salmon that depend on river delta estuaries for essential juvenile rearing habitat.

Recent trends

Recent trends remain challenging to quantify. A number of efforts are now under way to restore estuarine habitat because it is believed to be a bottleneck to the recovery and success of wild salmon and other species. Salmon recovery and watershed restoration groups are working with the support of state and federal partners to set local watershed-specific restoration targets, identify willing landowners, work through intense local politics, and restore habitat as part of their salmon recovery planning process. These efforts are technically complex, and often require public-private partnerships in a complex social, economic, and natural environment.

In contrast to project restoration efforts, habitat losses still occur. Habitat is still being impacted by on-going development, changes in river hydrology and sediment loads, and even the long-term effects of geologic subsidence of delta areas and sea level rise.

Recent advances in remote sensing technologies, improved geographic analysis tools, new ways of tracking fish movements, and better understanding of habitat functions all promise to improve our understanding of the net effect of habitat losses and gains over the coming years.



Chinook salmon river deltas



Figure 2.

Bridge Over Stillwaters

Carpenter Creek Estuary Restoration

Located at a critical crossroads for migrating salmon from river basins throughout Puget Sound, Carpenter Creek estuary near Kingston, Washington, is the last significant functioning estuary before leaving Puget Sound. This important salmon nursery provides young fish a place where they can eat, grow, and prepare for the long journey to the Pacific Ocean, including Chinook and coho salmon as well as steelhead and cutthroat trout.

For decades, an undersized culvert on South Kingston Road created a barrier for migrating fish that trapped juvenile salmonids at low tide, where they become easy prey. The culvert also prevented adequate water flow between the salt marsh and estuary. As a result, significant portions of the marsh were filling in with sediment, and fresh-water wetland species were encroaching into the upper saltmarsh.

In 2010, the Washington State legislature provided \$2.7 million through a state capital budget appropriation to

restore Carpenter Creek estuary because it provided critical habitat for endangered fish. Kitsap County used the funds to replace the culvert with a 90-foot single span bridge that restored natural tidal flow to estuary and saltmarsh habitat and allowed fish to move into and out of the 30-acre forested estuary habitat. Tide pools behind the culvert were also eliminated, making fish less vulnerable to predators.

Completed in February, 2012 the new South Kingston Road bridge was officially named the Stillwaters Fish Passage in honor of the advocacy work of Stillwaters Environmental Education Center.



Carpenter Creek Estuary



The new 90' span allows a more gentle flow for fish passage